

Important MOSFET Characteristics Formulas PDF



Formulas Examples with Units

List of 16 Important MOSFET Characteristics Formulas

1) Amplification Factor in Small Signal MOSFET Model Formula ↻

Formula

$$A_f = g_m \cdot R_{out}$$

Example with Units

$$2.25 = 0.5 \text{ mS} \cdot 4.5 \text{ k}\Omega$$

Evaluate Formula ↻

2) Bias Voltage of MOSFET Formula ↻

Formula

$$V_{be} = V_{bias} + V_{de}$$

Example with Units

$$8.3 \text{ V} = 5.3 \text{ V} + 3 \text{ V}$$

Evaluate Formula ↻

3) Body Effect on Transconductance Formula ↻

Formula

$$g_{mb} = X \cdot g_m$$

Example with Units

$$0.1 \text{ mS} = 0.2 \cdot 0.5 \text{ mS}$$

Evaluate Formula ↻

4) Conductance in Linear Resistance of MOSFET Formula ↻

Formula

$$G = \frac{1}{R_{ds}}$$

Example with Units

$$6.0241 \text{ mS} = \frac{1}{0.166 \text{ k}\Omega}$$

Evaluate Formula ↻

5) Conductance of Channel of MOSFET using Gate to Source Voltage Formula ↻

Formula

$$G = \mu_s \cdot C_{ox} \cdot \frac{W_c}{L} \cdot (V_{gs} - V_{th})$$

Evaluate Formula ↻

Example with Units

$$6.0724 \text{ mS} = 38 \text{ m}^2/\text{V}^* \text{s} \cdot 940 \text{ }\mu\text{F} \cdot \frac{10 \text{ }\mu\text{m}}{100 \text{ }\mu\text{m}} \cdot (4 \text{ V} - 2.3 \text{ V})$$

6) Gate to Source Channel Width of MOSFET Formula ↻

Formula

$$W_c = \frac{C_{oc}}{C_{ox} \cdot L_{ov}}$$

Example with Units

$$9.957 \text{ }\mu\text{m} = \frac{3.8\text{e-}7 \text{ }\mu\text{F}}{940 \text{ }\mu\text{F} \cdot 40.6 \text{ }\mu\text{m}}$$

Evaluate Formula ↻



7) Maximum Voltage Gain at Bias Point Formula ↻

Formula

$$A_{vm} = 2 \cdot \frac{V_{dd} - V_{eff}}{V_{eff}}$$

Example with Units

$$7.9412 = 2 \cdot \frac{8.45\text{ v} - 1.7\text{ v}}{1.7\text{ v}}$$

Evaluate Formula ↻

8) Maximum Voltage Gain given all Voltages Formula ↻

Formula

$$A_{vm} = \frac{V_{dd} - 0.3}{V_t}$$

Example with Units

$$7.9902 = \frac{8.45\text{ v} - 0.3}{1.02\text{ v}}$$

Evaluate Formula ↻

9) MOSFET Transconductance given Oxide Capacitance Formula ↻

Formula

$$g_m = \sqrt{2 \cdot \mu_n \cdot C_{ox} \cdot \left(\frac{W_t}{L_t} \right) \cdot I_d}$$

Example with Units

$$2.2866\text{ s} = \sqrt{2 \cdot 30\text{ m}^2/\text{V}^*\text{s} \cdot 3.9\text{ F} \cdot \left(\frac{5.5\text{ }\mu\text{m}}{3.2\text{ }\mu\text{m}} \right) \cdot 0.013\text{ A}}$$

Evaluate Formula ↻

10) Saturation Voltage of MOSFET Formula ↻

Formula

$$V_{ds(s)} = V_{gs} - V_{th}$$

Example with Units

$$1.7\text{ v} = 4\text{ v} - 2.3\text{ v}$$

Evaluate Formula ↻

11) Transconductance in MOSFET Formula ↻

Formula

$$g_m = \frac{2 \cdot i_d}{V_{ov}}$$

Example with Units

$$0.5\text{ mS} = \frac{2 \cdot 0.08\text{ mA}}{0.32\text{ v}}$$

Evaluate Formula ↻

12) Transition Frequency of MOSFET Formula ↻

Formula

$$f_t = \frac{g_m}{2 \cdot \pi \cdot (C_{sg} + C_{gd})}$$

Example with Units

$$5.2492\text{ Hz} = \frac{0.5\text{ mS}}{2 \cdot 3.1416 \cdot (8.16\text{ }\mu\text{F} + 7\text{ }\mu\text{F})}$$

Evaluate Formula ↻

13) Threshold Voltage of MOSFET Formula ↻

Formula

$$V_{th} = V_{gs} - V_{eff}$$

Example with Units

$$2.3\text{ v} = 4\text{ v} - 1.7\text{ v}$$

Evaluate Formula ↻



14) Voltage Gain given Drain Voltage Formula

Formula

$$A_v = \frac{i_d \cdot R_L \cdot 2}{V_{eff}}$$

Example with Units

$$0.0264 = \frac{0.08 \text{ mA} \cdot 0.28 \text{ k}\Omega \cdot 2}{1.7 \text{ V}}$$

Evaluate Formula 

15) Voltage Gain given Load Resistance of MOSFET Formula

Formula

$$A_v = g_m \cdot \frac{\frac{1}{\frac{1}{R_L} + \frac{1}{R_{out}}}}{1 + g_m \cdot R_s}$$

Example with Units

$$0.0261 = 0.5 \text{ mS} \cdot \frac{\frac{1}{\frac{1}{0.28 \text{ k}\Omega} + \frac{1}{4.5 \text{ k}\Omega}}}{1 + 0.5 \text{ mS} \cdot 8.1 \text{ k}\Omega}$$

Evaluate Formula 

16) Voltage Gain using Small Signal Formula

Formula

$$A_v = g_m \cdot \frac{1}{\frac{1}{R_L} + \frac{1}{R_{fi}}}$$

Example with Units

$$0.0264 = 0.5 \text{ mS} \cdot \frac{1}{\frac{1}{0.28 \text{ k}\Omega} + \frac{1}{0.065 \text{ k}\Omega}}$$

Evaluate Formula 



Variables used in list of MOSFET Characteristics Formulas above

- **A_f** Amplification Factor
- **A_v** Voltage Gain
- **A_{vm}** Maximum Voltage Gain
- **C_{gd}** Gate-Drain Capacitance (Microfarad)
- **C_{oc}** Overlap Capacitance (Microfarad)
- **C_{ox}** Oxide Capacitance (Microfarad)
- **C_{ox}** Oxide Capacitance (Farad)
- **C_{sg}** Source Gate Capacitance (Microfarad)
- **f_t** Transition Frequency (Hertz)
- **G** Conductance of Channel (Millisiemens)
- **g_m** Transconductance (Millisiemens)
- **g_m** Transconductance in MOSFET (Siemens)
- **g_{mb}** Body Transconductance (Millisiemens)
- **i_d** Drain Current (Milliampere)
- **I_d** Drain Current (Ampere)
- **L** Channel Length (Micrometer)
- **L_{ov}** Overlap Length (Micrometer)
- **L_t** Transistor's Length (Micrometer)
- **R_{ds}** Linear Resistance (Kilohm)
- **R_{fi}** Finite Resistance (Kilohm)
- **R_L** Load Resistance (Kilohm)
- **R_{out}** Output Resistance (Kilohm)
- **R_s** Source Resistance (Kilohm)
- **V_{be}** Total Instantaneous Bias Voltage (Volt)
- **V_{bias}** DC Bias Voltage (Volt)
- **V_{dd}** Supply Voltage (Volt)
- **V_{de}** DC Voltage (Volt)
- **V_{ds(s)}** Drain and Source Saturation Voltage (Volt)
- **V_{eff}** Effective Voltage (Volt)
- **V_{gs}** Gate-Source Voltage (Volt)

Constants, Functions, Measurements used in list of MOSFET Characteristics Formulas above

- **constant(s):** pi, 3.14159265358979323846264338327950288
Archimedes' constant
- **Functions:** **sqrt**, sqrt(Number)
A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.
- **Measurement:** **Length** in Micrometer (μm)
Length Unit Conversion 
- **Measurement:** **Electric Current** in Ampere (A), Milliampere (mA)
Electric Current Unit Conversion 
- **Measurement:** **Frequency** in Hertz (Hz)
Frequency Unit Conversion 
- **Measurement:** **Capacitance** in Microfarad (μF), Farad (F)
Capacitance Unit Conversion 
- **Measurement:** **Electric Resistance** in Kilohm (kΩ)
Electric Resistance Unit Conversion 
- **Measurement:** **Electric Conductance** in Millisiemens (mS), Siemens (S)
Electric Conductance Unit Conversion 
- **Measurement:** **Electric Potential** in Volt (V)
Electric Potential Unit Conversion 
- **Measurement:** **Mobility** in Square Meter per Volt per Second (m²/V*s)
Mobility Unit Conversion 



- V_{ov} Overdrive Voltage (Volt)
- V_t Thermal Voltage (Volt)
- V_{th} Threshold Voltage (Volt)
- W_c Channel Width (Micrometer)
- W_t Transistor's Width (Micrometer)
- μ_n Electron Mobility (Square Meter per Volt per Second)
- μ_s Mobility of Electrons at Surface of Channel (Square Meter per Volt per Second)
- X Change in Threshold to Base Voltage



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